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GEOPHYSICAL VARIABLES AND BEHAVIOR: LXXXVII. EFFECTS OF SYNTHETIC AND NATURAL GEOMAGNETIC PATTERNS ON MAZE LEARNING[1]

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Summary.—12 normal male albino rats were exposed or not exposed in their home cages for 5 min. and 50 sec. once every hour 8 times per night to a 7-Hz square-wave magnetic field whose amplitudes were shifted by about 50 nT approximately every 10 sec. Although there were no statistically significant differences between the two groups for numbers of working errors, numbers of reference errors, or speed during the acquisition of an Olton (8-arm) maze, the strength of the group differences (*F* ratios) for daily working errors was reduced (*rho* = .70) if there had been enhanced geomagnetic activity during the time of the night when the experimental fields were present.

Nocturnal increases of about 50 nT in geomagnetic activity or experimental 7-Hz magnetic fields whose amplitudes (50 nT) abruptly changed about once every 10 sec. have been shown to increase electrical seizure activity in rats with epilepsy (Michon & Persinger, 1997; Persinger, 1995). Recently we found that rats exposed hourly during the scotophase to a 7-Hz amplitude modulated magnetic field for 5 min. and 50 sec. eight times per night displayed a suppression in the symptoms of experimental allergic encephalomyelitis (Persinger, Cook, & Koren, 1999).

The present study was designed to discern if learning and memory of normal rats would be affected by this experimental field. Twelve male Wistar rats, about 200 days of age, served as subjects. Six of the rats were housed in plastic cages placed in one of two separate coils (3 rats/cage) while another six rats were housed in two cages (3 rats/cage) below this apparatus (Persinger, *et al.*, 1999). The light:dark cycle was 12:12 with light onset at 08 hr. Temperature was controlled between 20 and 21° C. After four days of habituating to 23-hr. food deprivation, the rats were trained in an Olton maze for 10 successive days between 0830 and 1030 hr. The numbers of working errors, reference errors, and total time to complete all eight arms were recorded daily.

During the first night after testing and for each of the subsequent eight nights the rats in the coils were exposed to the amplitude-modulated, 7-Hz square-wave magnetic field once every hour between midnight and 0706 hr. The field strengths and presence were verified by computer log. The inten-

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sity of the fields within the reference cages was less than 10 nT which was the limit of the measuring equipment. Repeated-measure analyses of variance were completed for the treatments (field vs reference) and days (10) for each of the three dependent measures and for the relative scores for these measures. For the latter, the numbers of errors or time to criteria for each of the last six days was divided by the mean of the values for the first four days before analysis.

There were no statistically significant differences for either absolute scores or relative scores between the two groups (all dfs = 1, 10) with respect to numbers of working errors (Fs = .52, .04), reference errors (Fs = 1.27, .39), or time (Fs = .44, .65). Although increased proficiency (learning) was statistically significant ($p < .01$) for all measures, only the interaction for days by treatment for working errors ($F_{9,90} = 1.73$, $p < .10$) were just shy of significance. However, the serial one-way analysis of variance indicated that on Days 2 and 5 the group differences for working errors fell short of statistical significance (Fs = 3.72; 4.82); the experimental group displayed more errors ($M = 3.7$, $SD = 2.3$; $M = 1.7$, $SD = 1.6$) compared to the reference group ($M = 1.6$, $SD = 1.0$; $M = .2$, $SD = .4$, respectively). To discern the possible interaction from geomagnetic activity, the F ratios for the differences between the two groups were correlated with the planetary a index and with each of the 3-hr. K-indices for each day from Boulder, Colorado (http.//www.dxlc.com/solar/indices.html).

Both parametric and nonparametric ($r = -.72$; $rho = -.76$) correlations ($df = 9$) were significant statistically ($p < .01$) only for the numbers of working errors and the index of geomagnetic activity at Boulder during the third 3-hr. interval universal time that corresponded to 02 hr. to 05 hr. local time when the experimental field was present. Partial correlations that first removed the effects of serial order for days of testing and the general planetary indices did not change the magnitude or statistical significance of the correlation. This association indicates that natural geomagnetic activity occurring at the same time as the experimental fields attenuated the differences in working memory between the two groups when tested during the photophase.

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